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# THE ECONOMIC STOCKAGE MODEL

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JUNE 1971**

BY  
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FINAL REPORT

JUNE 1971

by

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### ABSTRACT

An economic stockage model is formulated which determines a stockage policy to be used in generating a stockage list of items which satisfy selected supply support objectives at least cost. The policy is in the form of addition-retention levels which minimize the discounted cost over a large number of periods. An item is added to the stockage list if its demand frequency in a period is at least equal to the addition level; it is removed if the demand frequency is less than the retention level. No action is taken for demand frequency lying between the two levels. The model assumes that the mean demand frequency of an item is unknown but designated as a prior distribution.

Potential items for a stockage list are stratified into an 11 x 11 array of demand classes and extended price classes based on past history. The model finds an addition-retention pair for each extended price class. Aggregate statistics of the stratified items are used to project demand accommodation and stockage list size when using the stockage policy comprised of these 11 pairs. Input cost parameters may be varied to find policies which satisfy the supply support objectives.

The economic stockage model is used to find which items qualify for removal for economic reasons from a Korean stockage list generated by a demand criteria model.

## SUMMARY

### 1. Background

When building a list of items to be stocked by a supplier, some kind of rationale must be used to determine for each particular item whether to stock it or not. The rationale must depend upon one or more item characteristics - such as number of requisitions and total demand expected for the item over a period of time, unit price of the item, weight, cube, and essentiality. Various stockage criteria models can be developed by making different assessments of the relative importance of item characteristics, their predictability (in the case of future demand) and about the cost factors and constraints involved in creating a stockage list.

Currently, the Army uses a stockage criterion model which depends on expected number of demands for the item and its materiel category (MATCAT)\*. For each MATCAT there is a different addition-retention (a-r) criterion. These criteria are pairs of numbers, e.g. 9-3, which act as limits; if number of demands expected in a given base period for the item equals or exceeds the addition limit (e.g.9), the item is added to the stockage list. If number of demands is less than the retention limit (e.g. 3) the item is deleted from the stockage list. If number of demands is between the addition and retention criteria, item is in a "grey area". Normally, nothing is done to such items - if they are already on the stockage list they stay on, and vice versa. If a list is being

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\*Refinement of the model to its current state was done by Research Analysis Corporation [ 7 ].

developed from scratch, some fraction of the grey area items are included.

It was recognized by the Dept of the Army (I&L) and Army Materiel Command that the demand based stockage criterion model just described does not explicitly take into account the economics of stocking an item. AMC Inventory Research Office, Institute for Logistics Research, Army Logistics Management Center, was asked to assist in the development of an "economic" stockage model and to examine its usefulness.

## 2. Scope and Methodology

The immediate precursor of the model described here was a model developed by Lowell Goodhue of Logistics Management Institute [ 4 ]. A form of economic stockage model is actually in use by the British Army [ 2 ].

The model is an algebraic representation of the costs of stocking or not stocking an item as a function of the item unit price, expected number of demands and expected demand quantity. The solution procedure to determine "optimum" economic stockage criteria uses results from the theory of Markov processes, the theory of dynamic programming, and the economic analysis concept of present value.

Experience with the model was gained primarily by development of a test stockage list for a Korean Theater Inventory Control Center.

## 3. Findings and Conclusions

An economic stockage model was developed which was very successful in satisfying the desired objectives. In particular,

the model developed stockage lists which by projection would satisfy performance targets at much less cost than was possible with lists developed using a demand frequency criterion model. The projection techniques used an accepted methodology developed by Research Analysis Corporation.

Nevertheless, serious limitations on the usefulness of the economic stockage model are found. The problem stems from the fact that the performance targets were only surrogate measures of performance; i.e., the true measure of performance is the impact a stockage list has on operational readiness and troop morale, but since this cannot currently be quantified, the performance target is expressed in terms of stockage list accommodation. Accommodation is the percent of all demands on a supplier which are for items on his stockage list.

Examination of the economic stockage list indicated that it omitted many items which appear vital to military preparedness. Of course, this is a shortcoming of the demand criterion model also - due to the lack of a decent essentiality measure.

A short term use of the economic stockage model would be to identify items which are not economical for stockage, but which would be included strictly by demand criteria if economics were not explicitly considered. These items are of small enough number, although great impact, to be susceptible to manual review techniques. Development of such techniques is in progress, and a preliminary effort is described in Appendix C.

CHAPTER 1  
THE ECONOMIC STOCKAGE MODEL

1.1 Introduction

The objective of the economic stockage model is to develop a stockage list which will satisfy pre-specified supply support objectives at least cost. The supply support objective is typically stated in terms of desired accommodation; i.e., the percent of all demands\* on a stockage location which are for items on its stockage list.

The approach of the economic stockage model is to project the costs if an item is stocked and if it is not stocked and make the stockage decision based on which set of costs is smaller. Costs fall into three areas: operating and inventory costs, backorder costs, and turbulence costs if the status of the item changes - an item not on the list is put on, or one already on is taken off. Backorder costs are not really known, but instead are varied until that cost is found which results in a list providing the desired degree of supply support; e.g., raising the backorder cost results in the model placing more items on the stockage list, consequently improving demand accommodations and vice versa.

In applying the economic stockage model, it was found that the a-r criteria appropriate to an item were determined by the item's extended price (i.e., unit price x annual demand quantity). In general, as extended price increases, cost of keeping an item on the stockage list increases and, therefore, the number of demands necessary to justify adding or retaining it on the list increases. Therefore,

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\*In this report, demand, demand frequency, and number of requisition are equivalent entities. Demand quantity is exactly what it says.

extended price intervals were defined - \$0.-\$3., \$3-\$10., \$10-\$30., and so on - and different a-r criteria developed for items falling into each interval. Eleven intervals in all are defined.

## 1.2 Description of Cost Elements

Costs if item is not stocked. A backorder cost is charged for each demand received for the item. The cost has two components. One is the administrative costs involved in arranging for satisfaction of the demand. The second is the cost due to unavailability of material while the demand is on backorder. This second component is termed penalty cost.

Costs if item is stocked. Costs include inventory costs, fixed stockage costs, requisitioning costs and backorder costs.

Inventory costs, consistent with Dept of Defense practices, are calculated as a percent of the dollar investment in materiel. This percent represents opportunity cost for money tied up, storage costs, cost due to loss and obsolescence of materiel, and cost due to deterioration of materiel in storage. Inventory cost is applied only against average on hand stocks - in transit inventory is needed regardless of whether or not the item is stocked.

The fixed stockage cost is a cost incurred merely because an item is stocked. It is a management cost attributable to the cost of supply control studies, catalog upkeep, storage bin management, and so on.

Requisitioning costs cover the administrative costs of ordering replenishment quantities, of receiving the materiel, and also the administrative costs of the supplier from whom the stocks are ordered, e.g., the CONUS NICP.

Backorder cost in this case relates to demands which are back-ordered because of unavailability of stock (zero balance) for items on the stockage list. Penalty costs are the same as for non-stocked items but administrative costs can be smaller; the stocker may need only hold the demand until his replenishment order arrives.

Turbulence Costs. If an item is coming on or going off the stockage list, a turbulence cost is incurred. An addition cost covers the cost of setting up a storage bin location and initial paperwork. If the item is being removed, a fixed removal cost covers the reverse of the above process. A variable removal cost varies with the size of the inventory which must be removed or attritted when a removal decision is made.

#### 1.2.1 Mathematical Expressions for Cost Elements

In terms of cost parameters, we have the following 4 types of costs per period:

$$\text{Cost of restocking} = r_{11} = F + C_H + C_0 + u \lambda (C_B + C_{xs}) \quad (1.2.1)$$

$$\text{Cost of stocking} = r_{12} = r_{11} + C_A = \text{stockage \& addition cost} \quad (1.2.2)$$

$$\text{Cost of not stocking} = r_{21} = \lambda (C_B + C_{xn}) \quad (1.2.3)$$

$$\text{Cost of removal \& non-stockage} = r_{22} = r_{21} + C_R \quad (1.2.4)$$

where

- $F$  = fixed cost of stocking an item
- $C_H$  = holding cost
- $Q$  = economic order quantity
- $H$  = holding cost factor of average assets in percent
- $C_A$  = cost of adding item to list
- $C_B$  = penalty cost per requisition
- $C_{xn}$  = extra processing cost per requisition for items not stocked
- $C_{xs}$  = extra processing cost per requisition for items stocked but not available
- $C_O$  = cost of replenishment ordering per year
- $Q$  = reorder quantity
- $S$  = safety level quantity
- $C_R$  = removal cost
- $VRC$  = variable removal cost factor in percent
- $FRC$  = fixed removal cost
- $\lambda$  = estimate of mean number of requisitions per period (1 year)
- $L$  = cost to order
- $u$  = unavailability factor in percent
- $D$  = annual demand quantity
- $UP$  = unit price

where

$$C_O = L (D/Q) \quad (1.2.5)$$

$$C_H = (Q/2 + S) \times UP \times H \quad (1.2.5a)$$

$$Q = 7 \sqrt{D/UP} = q \quad \text{if } q \leq D/3 \quad (1.2.6)$$

$$= \max(D/3, q/3) \quad \text{if } q > D/3$$

$$C_R = (S + Q/2) \times VRC + FRC \quad (1.2.7)$$

Equations 1.2.5a and 1.2.5 followed from basic inventory theory.  $(D/Q)$  is the replenishment frequency.  $(Q/2 + S)$  is the appropriate average on hand inventory.

Equation 1.2.6 is the result of a study [5] on cost - minimizing quantity to order, commonly expressed as economic order quantity  $Q$ .

The unavailability factor represents an acceptable percent of requisitions which can be backordered.

### 1.2.2 Character of Cost Elements

The above cost parameters used in the economic stockage model can be classified by 3 types. The first type are approximations to actual cost factors (see bibliography for relevant studies used.) [3,4,5].

$$H = 40\%$$

$$C_{xn} = \$10$$

$$C_{xb} = \$4$$

$$L = \$10$$

$$VRC = 20\% \text{ (this is cost estimate if item had to be transported back to CONUS from overseas)}$$

$$u = 20\%$$

The second type consists of parameter values chosen which yield reasonable results (model outputs) and are themselves not unreasonable.

$$F = \$100 \text{ close to an upper bound on the real world value; turbulence and accommodation results are in an acceptable range.}$$

$$FRC = \$35 \left. \begin{array}{l} \text{usually constant at these values but at times} \\ \text{may be considered control variables (3rd type)} \end{array} \right\}$$

$$C_A = \$25$$

The third type of model input were control variables of cost. These costs were varied and the impact on model outputs such as accommodation, turbulence, and stockage list size observed, until satisfactory performance was achieved.

$C_B$  : basic control variable - a penalty cost ranging from \$8-\$150 per requisition

### 1.3 Choice of Optimum Addition - Retention Criteria

#### 1.3.1 A Simple Approach

Let us detail the procedure for determining a-r criteria if only 1-period costs are considered, i.e. the costs for the next year only. To find the level a such that if  $\lambda \geq a$  it "pays" to stock, we find the "break even" point between stocking cost  $r_{12}$  and not stocking cost  $r_{21}$ , i.e. we find the  $\lambda=a$  which makes  $r_{12}$  and  $r_{21}$  equal.

From (1.2.2) and (1.2.3)

$$C_O + F + C_H + u \cdot a \cdot (C_B + C_{xs}) + C_A = a \cdot (C_B + C_{xn}) \quad (1.3.1)$$

$$a = \frac{F + C_H + C_A + C_O}{(C_B + C_{xn}) - u (C_B + C_{xs})} \quad (1.3.2)$$

Similarly, to find the level r such that if  $\lambda < r$  it pays to remove the previously stocked item, we could equate restocking costs,  $r_{11}$ , to the sum of deletion and non-stockage costs,  $r_{22}$ . From (1.2.1) and (1.2.4)

$$C_O + F + C_H + u \cdot r (C_B + C_{xs}) = r(C_B + C_{xn}) + C_R \quad (1.3.3)$$

$$r = \frac{F + C_H - C_R + C_O}{(C_B + C_{xn}) - u (C_B + C_{xs})} \quad (1.3.4)$$

(1.3.2) and (1.3.4) are the optimal values for the (a-r) policy. If the expected mean  $\lambda \geq r$  the item is stocked. If the item is on the list in the preceding period, it is restocked until  $\lambda < r$  in the current period.

Inspection of 1.3.2 and 1.3.4 shows that the only elements which depend on item characteristics are  $C_R$ ,  $C_H$  and  $C_O$ . However, it is possible to prove that  $C_R$ ,  $C_H$  and  $C_O$  are a function of only one item characteristic - extended price ( $D \times UP$ ). Once extended price is known, the appropriate a-r criteria can be developed and then the stockage decision made. This leads to the use of the extended price interval concept as described in section 1.1.

#### 1.3.2 A Sophisticated Approach

There are two major deficiencies in the model of section 1.3.1.

(a) It considers only one period costs, yet actions taken now affect future years' costs. For example, suppose an item is on a stockage list and that:

- (1) cost of restocking( $r_{11}$ ) exceeds cost of not stocking( $r_{21}$ )
- (2) cost of restocking ( $r_{11}$ ) is less than cost of removal and not stocking ( $r_{22}$ )

The simple model uses the second comparison and keeps the item on the list; yet if it were removed, this would reduce future costs since  $r_{21}$  is less than  $r_{11}$ .

(b) The model is deterministic. In actual fact the true mean number of requisitions can be quite different from the estimate, which is typically based on 1 year's history.

It turns out that factor (b) dominates factor (a); that is, if the model of section 1.3.1 is used, turbulence - in the sense of the same item moving on and off the list more than once - is uneconomically high, because decisions are made without allowing for the possibility that the true demand is other than the estimate.

A more sophisticated approach to economic stockage considers costs over a planning horizon and derives these costs probabilistically. Such an approach is described in Chapter 2. The dependence of the appropriate a-r criteria on the extended price of the item remains, and the use of extended price intervals is retained. The simple relations for a & r in (1.3.2) and (1.3.4), which minimize one period costs for a known mean  $\lambda$ , no longer hold. The relation of the a-r criterion to the infinite horizon costs is complex. The power of the forthcoming model is that it presents a rational approach for finding the cost-minimizing a-r policy.

## CHAPTER 2

### DESCRIPTION OF ALGORITHM

#### 2.1 Attributes of Model

##### 2.1.1 Concept and Scope

A model was desired which would generate the addition-retention criteria for an item in a given extended price class which minimizes the expected cost over an infinite time horizon. Since an item's mean demand frequency is uncertain, the model should be able to accept a prior distribution of means of demand frequency.

A Markovian decision model was formulated with the following attributes:

- a. One period cost parameters, extended price, discount factor, prior distribution of mean number of requisitions are inputs for each extended price category.
- b. Outputs are a-r levels for each extended price category and the expected cost resulting from following the recommended a-r stockage policy.
- c. A grid search over the most feasible set of a-r levels is used to find the recommended policy.
- d. An iterative design procedure can be formulated to find those input cost parameters which yield final stockage size, (#FSN's), accommodations, and turbulence values which are satisfactory.
- e. The model is flexible in that it can accept most demand distributions of concern; it can be refined to generate a more sophisticated stockage policy with further minimization of cost; it can be simplified to yield a single a-r pair for a given MATCAT.

### 2.1.2 Discounted Cost Concept

In measuring costs in the minimization process, future costs are discounted (i.e. deflated). The basic concept is a common one in economic analysis, and is described, for example, in DOD Instruction 7041.3 (Feb 69). If the discount factor is  $i$  and costs in year  $t$  are designated  $V_t$ , then total discounted cost,  $V_o$ , is defined as

$$V_o = \sum_{t=1}^{\infty} \frac{V_t}{(1+i)^t}$$

DOD Instruction 7041.3 recommends an  $i$  of 10% based on opportunity costs, which relates to the advantages of postponing costs. In the current context, the possibility of obsolescence also must be considered - all future costs are conditional on the item not becoming obsolete and demand for it ceasing. Allowing for obsolescence,

$$V_o = \sum_t \frac{V_t}{(1+i)^t} [(1-o)^t]$$

where  $o$  is an obsolescence rate and  $(1-o)^t$  is the probability the item is not obsolete by year  $t$ . To simplify, we approximate

$$V_o = \sum_t V_t (\alpha)^t$$

where  $\alpha = \frac{1}{1+i+o}$

A typical value used for  $o$  is 5%;  $\alpha$  in the examples of Chapter 3 is set to 85%.

### 2.2 Model Formulation

In a given period an item can be in one of two states - either on

or off the stockage list. Associated with each state is a one period cost of stocking or not stocking the item. Our task is only to show that the transition from state to state from one period to the next is Markovian and we have the basis for a Markovian decision model.

We assume the number of requisitions is Poisson distributed with unknown mean. The state transitions are then Markovian. For a given mean demand frequency  $\lambda$  we then can construct the probability transition matrix from period  $n$  to period  $n+1$

$$\begin{array}{cc|cc} & \text{on} & \text{off} & & \\ \text{on} & P_r & 1-P_r & \tilde{A} = A = & \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} \\ \text{off} & P_a & 1-P_a & & \end{array} \quad (2.2.1)$$

The probability the item is on the list and stays on in the next period is the probability that the number of requisitions received is at least equal to the retention level  $r$ , i.e.

$$P(x \geq r; \lambda) = \sum_{x=r}^{\infty} P_{ois}(x; \lambda) = P_r \quad (2.2.2)$$

Similarly the item is added to the list in period  $n+1$  with probability  $P_a$

$$P(x \geq a; \lambda) = \sum_{x=a}^{\infty} P_{ois}(x; \lambda) = P_a \quad (2.2.3)$$

To obtain expressions for expected costs we make two assumptions. One assumption is that the demand frequency distribution is stationary over the planning horizon. More specifically  $\lambda_n = \lambda$  for all  $n$ . Also it is assumed an item does not migrate from its original extended price category.

Associated with the probability transition matrix is the one period risk or cost matrix

$$\begin{array}{cc|cc} & & \text{on} & \text{off} \\ \text{on} & & r_{11} & r_{12} \\ \text{off} & & r_{21} & r_{22} \end{array} = R \quad (2.2.4)$$

$r_{11}$  = one period cost of restocking the item

$r_{12}$  = cost of removing item and not stocking for the period

$r_{21}$  = cost of adding item and stocking for the period

$r_{22}$  = one period cost of continuing not to stock the item

Expressions for  $r_{11}$  were given in section 1.2.1.

Given matrices  $A, R$ , mean demand frequency  $\lambda$ , a discount factor  $\alpha$ , the expected discounted cost over the planning horizon  $V(\lambda)$  can be computed for a given a-r policy. This is weighted by a prior distribution of the mean demand frequency  $g(\lambda)$

$$V = \sum_{\lambda} V(\lambda)g(\lambda) \quad (2.2.5)$$

Section 2.3 derives the appropriate expressions for  $V(\lambda)$  and formulates the algorithm for minimizing  $V$ . Section 2.4 develops the feasible set of a-r policies over which to search to find the optimal policy. In section 2.5 the rationale for theoretical and empirical development of  $g(\lambda)$ , which expresses our uncertainty in the value of mean  $\lambda$ , is explained.

## 2.3 Expected Discounted Costs

### 2.3.1 Recurrence Relation

Let  $\{q\}$  denote the set of feasible a-r levels to be considered in minimizing the expected discounted cost. Each  $q$  is a pair of numbers  $(a, r)$ . Defining

$V_{i,n}(\lambda)$  = total expected cost from an n-stage process  
starting in state  $i$ , using a fixed policy and  
given a particular value  $\lambda$  for mean of demand  
frequency.

The minimum cost  $V^*(\lambda)$  satisfies the recurrence relation,

$$V_{i,n}^*(\lambda) = \min_{\{q_i\}} \left[ \sum_{j=1}^2 P_{ij}(q, \lambda) r_{ij}(\lambda) + \alpha P_{ij}(q, \lambda) V_{j,n-1}^*(\lambda) \right] \quad i = 1, 2 \quad (2.3.1)$$

where

$i$  or  $j = 1$  refers to state 1 : item is on list

$i$  or  $j = 2$  refers to state 2 : item is off list

$\alpha$  = discount factor

Equation (2.3.1) follows from Bellman's Principle of Optimality, where the first term is the expected one-period cost with a transition from state  $i$ . Note that (2.3.1) is actually two equations and two pairs of numbers  $q_1^*$  and  $q_2^*$  should be found to minimize  $V_1$  and  $V_2$ .  $q_1^*$  is the a-r policy to be used if initially the item is on the list;  $q_2^*$  is used if initially the item is off the list.

$$V_n^*(\lambda) = \min_k [b(k, \lambda) + \alpha A(k, \lambda) V_{n-1}^*(\lambda)] \quad (2.3.2)$$

where  $k = \{q_1, q_2\}$  = set of all feasible 2 pairs of a-r levels

$$\text{and } b_i(k, \lambda) = \sum_{j=1}^2 P_{ij}(q_i, \lambda) r_{ij}(\lambda) \quad (2.3.3)$$

### 2.3.2 Minimization Algorithm

We wish to find the optimal policy  $k$  which satisfies (2.3.2) for large  $n$ . Since  $\alpha < 1$  and the norm  $\|A\|$  of matrix  $A \leq 1$ , it is known that  $V_n \sim V_{n-1} \rightarrow V$ , a steady-state value as  $n \rightarrow \infty$ . With this knowledge Howard's Policy Iteration technique [1,6] could have been used to solve (2.3.2) for the optimal "doublet" policy  $\{q_1, q_2\}$

Since we can assume all items are off the list initially, we are concerned with minimizing  $V_2 = \sum_{\lambda} V_2(\lambda) q(\lambda)$ . From (2.3.2) we write the steady-state non-minimal cost relationship

$$V(\lambda, k) = b(\lambda, k) + \alpha A(\lambda, k) V(\lambda, k) \quad (2.3.4)$$

The following intuitively appealing algorithm is used to find  $k^*$ .

- a. Let  $k = (q, q)$ , i.e. we dispense with the "doublet" policy since we are only interested in minimizing  $V_2$ .
- b. Solve  $V(\lambda, q) = b(\lambda, q) + \alpha A(\lambda, q) V(\lambda, q)$  for all potentially optimal policies  $q$
- c. Weight each  $V(\lambda, q)$  by  $g(\lambda)$
- d. Choose the policy  $q^*$  which minimizes  $\sum_{\lambda} V_2(\lambda, q) g(\lambda)$

This method assures us that of the set of policies  $\{q\}$  considered, we have found the policy  $q^*$  which minimizes the expected value, over the distribution  $g(\lambda)$  of uncertain mean demand frequency, of the conditional discounted cost given a mean  $\lambda$ . In mathematical terms

$$\min_q \left( E_{\lambda} [E(V|\lambda)] \right) = \min_q (E(V)) \quad (2.3.5)$$

which is an identity in the calculus of expectations.

## 2.4 The Policy Set $\{q\}$

When minimizing the function  $V$  over a policy set  $\{q\}$  one wishes to be sure that a policy is included that produces the global optimum or near to it. One way to generate a policy set  $\{q\}$  is sequential generation. The cost and/or function of cost (such as the derivative with respect to  $q$ ) is found for one or more policies and the resulting values are used in a recurrence relation to obtain a new policy to be evaluated. The new policies generated recursively should converge to the optimal policy  $q^*$ . Such methods are amenable to internal generation by computer; the size of  $\{q\}$  is relatively small since the search is not exhaustive. Gradient search techniques (including Newton-Raphson) and two point interval searches (i.e. Fibonacci, Regula Falsi) were investigated but found wanting. We could not make the unimodality or convexity assumptions for  $V$  and its derivatives needed to apply these techniques; hence, we could not be certain of a global minimum or even convergence. Moreover, simultaneous optimization over two variables ( $q = (a, r)$ ) introduces problems in the form of constraints.

It was felt that an exhaustive grid search over feasible ranges of  $a$  and  $r$  would be practical if the resulting number of pairs  $(a, r)$  was not too large ( $< 80$ ). The first step in determining the ranges of  $a$  and  $r$  was to find the "threshold mean"  $\lambda_e$  defined as follows: if the true mean number of requisitions equals  $\lambda_e$ , the period costs of stocking or not stocking are equal. Using the approach of section 1.3.1,  $\lambda_e$  is easily found to be

$$\lambda_e = \frac{F + C_H + C_0}{(C_B + C_{xn}) - u, (C_B + C_{xs})}$$

Any item with expected requisitions below  $\lambda_e$  clearly should not be added to the stockage list. So the lower bound of  $a$  is  $\lambda_e$ . Moreover if the true mean  $\lambda_T < \lambda_e$  the chances are small ( $< 5\%$ ) that the observed demand frequency would be more than 2 standard deviations above  $\lambda_e$  (the standard deviation for the assumed Poisson distribution of demand would be  $\sqrt{\lambda_T}$ ). Since forecasted frequency is based on observed frequency, if  $a$  were set to  $\lambda_e + 2\sqrt{\lambda_T}$ , it is unlikely that items with mean  $< \lambda_e$  would appear on the list, though many items with  $\lambda > \lambda_e$  might be kept off.  $\lambda_e + 2\sqrt{\lambda_T}$  is a rough upper bound therefore. By analogous reasoning, we conclude:

$$\lambda_e \leq a \leq \lambda_e + 2\sqrt{\lambda_e} \quad (2.4.1)$$

$$\lambda_e - 2\sqrt{\lambda_e} \leq r \leq \lambda_e \quad (2.4.2)$$

A coarse grid was set up with grid size  $d = \max(2, .10\lambda_e)$  and constraints  $r < a$ ,  $a > 1$ ,  $r > 0$ ,  $a$  and  $r$  integers; all possible combinations of  $a$  and  $r$  were used in our policy set  $\{q\}$ . The "optimal"  $q^+$  was then perturbed by plus and minus  $\max(1, .05\lambda_e)$  for "finer tuning" to the optimum  $q^*$ .

## 2.5 Prior Distribution of Means of Demand Frequency $g(\lambda)$

There are two ways to develop a distribution function - empirically and theoretically. The first consideration was a theoretical distribution for  $g(\lambda)$  to fit the degree of uncertainty about the mean number of requisitions. The gamma function  $g(\lambda; a, b)$  with parameters  $a, b$  was investigated; it could be compounded with the Poisson demand distribution to yield a negative binomial distribution and its shape was flexible with changing  $a, b$  parameters. However, the cost expressions obtained

using negative binomial transition probabilities are not equal to the mathematically rigorous expression obtained by weighting  $V_n(\lambda)$  by a  $g(\lambda)$ . With any theoretical  $g(\lambda)$ , no convenient closed form expression for  $\sum V(\lambda)g(\lambda)$  exists.

The possibility of using empirical data to generate histograms which would serve as a priori distributions  $g(\lambda)$  for items in each extended price class was then considered. The data processing of demand data from a theatre and subsequent generation of histogram is described below:

a. For a given theatre (KOREA), the items in each materiel category (e.g. MATCAT T-industrial supplies) were classified according to extended price and demand category, i.e. an 11 x 11 matrix of cells was used to store aggregate information on the item. The 11 extended price and 11 demand frequency categories are given in table 2.1.

Ext. Price	Cell	Demand Freq.	Cell
\$0-3	(1,j)	0-2	(1,1)
\$3-10	(2,j)	3-4	(1,2)
\$10-30	(3,j)	5-6	(1,3)
\$30-100	(4,j)	7-8	(1,4)
\$100-\$300	(5,j)	9-10	(1,5)
\$300-1000	(6,j)	11-15	(1,6)
\$1000-3000	(7,j)	16-20	(1,7)
\$3000-10000	(8,j)	21-50	(1,8)
\$10000-30000	(9,j)	51-100	(1,9)
\$30000-100000	(10,j)	101-500	(1,10)
> 100,000	(11,j)	> 500	(1,11)

TABLE 2.1

Each cell in the matrix contains the following data: total number of items, total number of requisitions on these items, total demand quantity, total extended price.

b. For each row  $i$  (extended price class) of the matrix, a histogram of  $11$  demand frequencies is generated. The  $11$  values for the mean  $\lambda$  and associated probabilities of occurrence are found as follows

$$\lambda_{ij} = \frac{\text{number of requisitions in cell } (i,j)}{\text{number of items in cell } (i,j)}, j = 1, 11 \quad (2.5.1)$$

$$p_{ij} = \frac{\text{number of items in cell } (i,j)}{\text{total number of items in row } i}, j = 1, 11 \quad (2.5.2)$$

c. For each extended price class  $i$  in MATCAT T, the weighted cost to be minimized is given by (2.5.3)

$$V_{2i} = \sum_{j=1}^{11} V_{2i} (\lambda_{ij}) p_{ij} \quad (2.5.3)$$

With only one year data base available and lack of heuristic or theoretical development of a  $g(\lambda)$ , the average values in 2.5.1 and 2.5.2 are justifiable statistics for an empirical distribution of means  $g(\lambda)$ .

## 2.6 Model Advantages and Disadvantages

a. With an assumption of slow drift in demand pattern, the model determines an optimal stockage policy, minimizing costs. By this measure, the model is superior to previous models. As with the previous models, it does not consider the essentiality of an item because of the current lack of essentiality coding for each item.

b. The model is a systematic procedure for determining the effect of cost parameters and item characteristics on stockage policy. In a rational manner the stockage policy is found which meets stockage list requirements for least investment.

c. The concept of categorizing items by their extended price has advantages and disadvantages. If one adds items with yearly requisitions  $\geq a$ , without regard to extended price, one could be adding \$1.00 and \$10,000 items with equal ease. Items with the same extended price and requisition frequency incur the same stockage and non-stockage costs; hence, they should have the same a-r criteria. However, if demand fluctuates greatly from period to period, an item could migrate to other extended price classes, and the previous a-r criteria would no longer be valid.

d. The inherent flexibility of the Markov model is advantageous when considering the following: the use of demand data to generate histograms is acceptable with a reasonably large data base; with little data, a reasonable theoretical distribution  $g(\lambda)$  may be used with parameters to reflect the physical situation. The cost expressions and transition probability expressions may be weighted by  $g(\lambda)$  in a manner depending upon the theoretical distribution.

A refined Markov decision model may be formulated to incorporate a sophisticated forecasting scheme. Exponential smoothing of various orders would be reflected in the transition probabilities. Markov models with more than 2 states may be required.

### CHAPTER III

#### APPLICATION OF ECONOMIC STOCKAGE MODEL

This chapter describes the application of the Economic Stockage Model in a test situation. The test objective was to develop a stockage list for the Korean theater inventory control point. The list was to be organized by materiel category (MATCAT) and to satisfy constraints on list size, accommodation, and turbulence.

Procedures, results, and conclusions are discussed.

#### 3.1 Inputs

A one year demand data base from U.S. Army - Korea was given by MATCAT.

The MATCATS of consequence on the Korea list are:

<u>MATCAT</u>	<u># Items in MATCAT for Which Demands Were Recorded in Korea</u>
B - Ground Forces Support	3689
E - General Supplies	9069
F - Clothing & Textiles	2221
G - Electronics	6646
H - Air Materiel	4828
J - Ground Forces Support - DSA	19997
K - Combat & Automotive	8079
M - Weapons & Fire Control	4359
Q - Electronics - DSA	16052
R - Petroleum Products	565
T - Industrial Supplies	15083

TABLE 3.1

Performance targets were set as follows: list size not to exceed 30,000 items; percent accommodation to be at least 80% for each MATCAT;

overall turbulence under 5%.

Percent accommodation for a MATCAT is the percent of total valid requisitions in that MATCAT that are for items on the stockage list. Overall percent turbulence is the annual turnover of items on the entire stockage list - if in the beginning of the year there are  $n$  items on the entire list, and if at beginning of the next year the stockage list contains only  $x$  of these  $n$  items plus new additions, turnover percent is  $(\frac{n-x}{n}) \times 100$ .

Table 3.1 summarizes the cost parameters used as discussed in Chapter 1.

Discount Factor $\alpha$ = .85	
Addition Cost $C_A$ = \$35	} For all MATCATS except H H: \$90, \$90
Fixed Removal Cost = \$35	
Fixed Stockage Cost $F$ = \$100	
Variable Removal Cost = 20%	
Processing Cost for requisitions of items not stocked $C_{xn}$ = \$10	
Processing cost for requisitions of items not available $C_{xs}$ = \$4	
Holding cost $H$ as % of average value on hand assets = 40%	

TABLE 3.1 Fixed Parameters

### 3.2 Procedure

The Economic Stockage Model is used in conjunction with a computer program which acts as a performance projector. This program could project the average size, accommodation and turbulence of the Korean stockage list which would result from the continued use in Korea of

any given candidate set of a-r criteria. Inputs to the program are the candidate criteria, and Korean demand history, appropriately stratified. The program, which is described in Appendix B, is based on methodology developed by Research Analysis Corporation. The theoretical probabilities for turbulence used in the program are given in Appendix A.

The heart of the whole procedure is an iterative design. Cost inputs are translated into a-r criteria by the economic model. The performance projector translates the a-r criteria into likely performance results. If these results violate any of the performance targets, some of the cost inputs are adjusted and the process is repeated. The adjustment is made generally to the cost of a backorder, which, as discussed in Section 1.2.2, is not known, but is treated as a control. In some applications the type 2 costs identified in Section 1.2.2 might also need to be adjusted, and in some cases the performance targets may be unrealistic.

A description of the full procedure follows. While there are many steps, most are programmed on a timesharing computer and none takes more than a few minutes.

- a. A MATCAT, e.g., T, is selected. A histogram of demand frequencies is computed. The histogram is required as input to the economic stockage model (see Section 2.2.5).

- b. List elements are inputted for types 1 and 2 costs (as discussed in Section 1.2.2)

- c. A value for penalty or backorder cost is chosen.

- d. The economic stockage model is used to develop a-r criteria.
- e. The performance expected from these criteria is projected.
- f. Projected accommodation is compared to the target. If it is not close, an adjustment is made to the penalty cost and steps d through f are repeated. In particular, if accommodation is too low, the penalty cost is increased and vice versa.
- g. If accommodation target is met, the a-r criteria from step d. and expected performance from step e. are recorded. If not all MATCATS have been done, steps a. through g. are repeated for another MATCAT.
- h. If all MATCATS have been done, the recorded values of list size and turbulence by MATCAT are checked. Total list size and overall turbulence is computed.
- i. If turbulence and list size constraints are met, procedure ends. Otherwise, steps b-h are repeated with an adjustment in the type 2 cost inputs. If the list size constraint has been violated, the fixed cost of stocking is increased. If turbulence is too high, turbulence costs are increased. If overall turbulence is too high because of very high turbulence in a few MATCATS, turbulence costs for these MATCATS only are adjusted.

### 3.3 Tabulated Results

Table 3.2 gives the Korean test addition-retention criteria by MATCAT. The first column identifies the extended price interval to which each a-r pair applies. Under the MATCAT identified in the first row is given the penalty cost parameter used to get 80% accommodation.

TABLE 3.2 ADDITION-RETENTION CRITERIA BY MATCAT  
& EXTENDED PRICE

	MATCAT & PENALTY COST				
	B \$30	E \$20	F \$30	G \$50	H \$155
\$ 0-3	6-1	8-2	7-1	5-1	3-1
\$ 0-10	7-1	8-2	7-1	5-1	3-1
\$10-30	7-1	8-2	7-1	5-1	3-1
\$30-100	7-1	9-1	7-1	5-1	3-1
\$100-300	7-2	9-1	7-2	5-1	3-1
\$300-1000	9-1	11-3	9-1	7-1	4-1
\$1000-3000	12-4	16-6	12-4	10-2	4-1
\$3000- 10000	22-10	26-17	22-10	15-5	7-1
\$10,000 - 30,000	49-34	53-38	49-34	29-17	13-3
\$30,000 - 100,000	107-88	130-93	107-88	65-34	35-12
> \$100,000	301-225	368-301	301-225	184-150	66-54

TABLE 3.2 ADDITION-RETENTION CRITERIA BY MATCAT  
(cont) & EXTENDED PRICE

EXT. PRICE	MATCAT & PENALTY COST					
	J \$30	K \$8	M \$25	Q \$50	R \$30	T \$30
\$ 0-3	7-1	11-3	7-1	5-1	6-1	6-1
\$3-10	6-1	12-2	7-1	5-1	7-1	6-1
\$10-30	7-1	12-4	8-1	5-1	7-1	6-1
\$30-100	7-1	13-5	8-2	5-1	7-1	7-1
\$100-300	7-2	14-4	9-1	5-1	7-2	7-2
\$300-1000	9-1	17-5	10-2	6-1	9-1	9-1
\$1000-3000	12-4	23-11	14-4	9-1	12-4	13-5
\$3000- 10,000	22-8	52-22	25-9	15-5	22-10	22-6
\$10,000- 30,000	51-21	52-30	54-37	29-17	49-34	52-34
\$30,000- 100,000	112-84	217-155	117-96	65-40	107-88	126-88
> \$100,000	276-225	500-480	315-258	175-125	301-225	276-225

For purposes of comparison, Table 3.3 gives the single a-r pair for each MATCAT which is found using demand criteria only; i.e. without regard to economic cost elements, so that the a-r criteria do not depend on extended price. These criteria, originally found by Research Analysis Corporation, gives 80% accommodation and 1%-5% turbulence.

MATCAT	B	E	F	G	H	J	K	M	Q	R	T
a-r Demand	10	12	20	6	3	8	18	7	7	26	7
Criteria	3	4	12	1	1	2	8	2	1	14	1

TABLE 3.3

Table 3.4 compares the performance statistics projected for the economic a-r criteria to those projected using the demand criteria. "\$ R+Q" represents the projected dollar value of inventory investment in the items on the stockage list. Inventory investment for an item is set equal to the dollar value of the items requirements objective, to be consistent with previous work (unpublished) in this area.

#### 3.4 Interpretation of Results

The economic stockage criteria clearly achieve the same accommodation as the demand criteria with much smaller total investment.

Unfortunately, this does not mean the economic criteria are necessarily better. For the ultimate measure of performance is contribution to combat readiness, not accommodation. Manual comparison of lists produced using both sets of criteria showed that the

**TABLE 3.4 - AGGREGATE STATISTICS BY KOREAN MATCAT USING****ECONOMIC POLICY & DEMAND POLICY**

<b>MATCAT</b>	<b># FSNs STOCKED</b>	<b>TURBULENCE %</b>	<b>ACCOMMODATION %</b>	<b>\$ R+Q</b>
<b>B</b>				
<b>Economic</b>	<b>1224</b>	<b>1.24</b>	<b>79.7</b>	<b>589,550</b>
<b>Demand</b>	<b>969</b>	<b>1.55</b>	<b>80.1</b>	<b>3,339,243</b>
<b>E</b>	<b>3201</b>	<b>.94</b>	<b>83.6</b>	<b>1,450,674</b>
	<b>2467</b>	<b>1.12</b>	<b>81.5</b>	<b>2,410,304</b>
<b>F</b>	<b>1150</b>	<b>.81</b>	<b>78.4</b>	<b>1,248,143</b>
	<b>708</b>	<b>1.95</b>	<b>80.8</b>	<b>4,922,452</b>
<b>G</b>	<b>2178</b>	<b>3.05</b>	<b>79.3</b>	<b>597,473</b>
	<b>2162</b>	<b>1.77</b>	<b>80.8</b>	<b>994,619</b>
<b>H</b>	<b>2461</b>	<b>12.90</b>	<b>80.4</b>	<b>783,233</b>
	<b>2604</b>	<b>12.00</b>	<b>83.2</b>	<b>1,946,559</b>
<b>J</b>	<b>6215</b>	<b>1.55</b>	<b>80.7</b>	<b>1,568,612</b>
	<b>5149</b>	<b>1.96</b>	<b>80.6</b>	<b>4,022,732</b>
<b>K</b>	<b>1646</b>	<b>.85</b>	<b>80.0</b>	<b>1,738,835</b>
	<b>1419</b>	<b>1.43</b>	<b>82.3</b>	<b>3,840,405</b>
<b>M</b>	<b>1288</b>	<b>1.10</b>	<b>78.9</b>	<b>397,298</b>
	<b>1239</b>	<b>1.78</b>	<b>79.6</b>	<b>762,567</b>
<b>Q</b>	<b>5657</b>	<b>3.05</b>	<b>82.6</b>	<b>830,719</b>
	<b>4789</b>	<b>1.20</b>	<b>80.0</b>	<b>1,062,906</b>
<b>R</b>	<b>195</b>	<b>1.21</b>	<b>82.9</b>	<b>1,951,274</b>
	<b>84</b>	<b>1.18</b>	<b>81.8</b>	<b>2,669,622</b>
<b>T</b>	<b>5061</b>	<b>1.75</b>	<b>79.4</b>	<b>398,711</b>
	<b>4857</b>	<b>1.25</b>	<b>79.2</b>	<b>615,552</b>
<b>TOTALS</b>	<b>30,276</b>	<b>2.59%</b>	<b>80.5</b>	<b>\$11,554,522</b>
	<b>26,447</b>	<b>2.47%</b>	<b>80.9</b>	<b>26,586,961</b>

economic criteria, as well as the demand criteria, kept some items off the list which could adversely affect readiness. If readiness could be quantitatively measured, or even if item essentiality could be measured, this could be easily built into the economic model approach. At this point, neither is possible.

The most immediate application of the economic model is to indicate items which would be kept off an economic list, but put on a strict demand list, yet for which quick supply is not essential to combat readiness. This has been done for Korea and includes such items as playing cards, bed sheets, etc. Appendix C gives more detail.

The model has been used to generate economic a-r criterion from 1 year demand histories for the Alaskan and Southern Command theaters. (unpublished). Also 2 years of Korean history were used against the Korean a-r criterion (generated by 1 year of demand history) and accommodation and turbulence projections were measured (technical note to be published).

Another potential application of the general model approach is to develop stockage lists where there are weight or cube constraints. "Cost" of stocking an item would then be:

$$A + (b \cdot M) + \text{penalty cost}$$

where "a" and "b" are parameters and M is a measure of what is being constrained, e.g. weight of an item. Cost of not stocking as in the pure economic model is based on penalty cost only, which is larger than if the item is stocked (see equations 1.2.1-1.2.7).

## APPENDIX A

### PROBABILITY OF ITEM BEING ON LIST AND PROBABILITY OF TURBULENCE

A stockage policy is given such that an item will remain on a stockage list if its demand frequency during the considered period  $\geq r$ , and the item will be added (if it is off) if its demand frequency  $\geq a$ , where  $a > r$ . A theoretical expression for turbulence probability may be determined from the steady-state probability of being "on" the stockage list.

Let  $P_r$  = probability item will be retained in present period  
of review

$P_a$  = probability item will be added in present period  
of review

Then the following recursive relations will exist from review period  $n-1$  to review period  $n$ .

$$P_{on}(n) = P_r P_{on}(n-1) + P_a P_{off}(n-1) \quad (A1)$$

$$P_{off}(n) = (1-P_r)P_{on}(n-1) + (1-P_a)P_{off}(n-1) \quad (A2)$$

In steady state ( $n \rightarrow \infty$ )  $P_{on}(n) = P_{on}(n-1) = P_{on}$ , and  $1-P_{on} = P_{off}$

Therefore from either A1 or A2

$$P_{on} = \frac{P_a}{1-P_r+P_a} \quad (A3)$$

Then turbulence is defined as the joint probability of being on and going off in the present period.

$$T = P_{on} (1-P_r) = \frac{P_a (1-P_r)}{1-P_r+P_a} \quad (A4)$$

If the base period (period over which demand is compared to  $a$  and  $r$  levels to determine stockage policy) equals review period, then  $P_a$  and  $P_r$  assume the simple forms (2.2.2) and (2.2.3).

$$P(x \geq r; \lambda) = \sum_{x=r}^{\infty} P_{ois}(x; \lambda) \quad A(5)$$

$$P(x \geq a; \lambda) = \sum_{x=a}^{\infty} P_{ois}(x; \lambda) \quad A(6)$$

RAC obtained (A3) and (A4) in a slightly different manner.

## APPENDIX B

### AGGREGATE STATISTICS PROGRAM

The 11 x 11 matrix of items stratified by demand and extended price (as described in Chapter II) is compared to the 11  $(a_i, r_i)$  criteria by the aggregate statistic program. The mean demand frequency  $\lambda_{ij}$  for a base period of 1 year is given by eq. (2.5.1). If the mean demand frequency  $\lambda_{ij} \geq a_i$ , all items in cell  $i, j$  are put on the list. If  $\lambda_{ij} < r_i$  all items in cell  $i, j$  are kept off. The steady state probability of being "on",  $P_{on}$  (see Appendix A), is used to determine the fraction of "gray" items (those in cells for which  $r_i \leq \lambda_{ij} < a_i$ ) in a cell which one would expect to be on the list over a long period of time. Percent accommodation is found as follows:

$$\% \text{ Accom} = \frac{\sum_{i,j} (\# \text{ Requisitions in cell } i,j) \times \text{FRAC}}{\sum_{i,j} (\# \text{ requisitions in cell } i,j)} \quad (\text{B.1})$$

$$\text{where FRAC} = \begin{cases} 1 & \text{if } \lambda_{ij} \geq a_i \\ 0 & \text{if } \lambda_{ij} < r_i \\ P_{on}(\lambda) & \text{if } r_i \leq \lambda_{ij} < a_i \end{cases}$$

Also:

$$\% \text{ Turbulence} = \frac{\sum_{i,j} (\# \text{ items in cell } i,j) \times T(\lambda_{ij})}{\sum_{i,j} (\# \text{ items in cell } i,j) \times \text{FRAC}} \quad (\text{B.2})$$

where  $T(\lambda_{ij})$  is given in Appendix A by eq. (A4). Note turbulence probability  $T$  is a function of  $\lambda_{ij}$  from (A5) and (A6).

It should be noted that the projection of accommodation given in (B.1) may tend to overestimate actual accommodation for MATCATS with very low demand profiles. The mean demand frequency  $\lambda_{ij}$  is computed from 1 year of demand history. However, in the future,

there may be recorded demands for items which had zero demands in the one year history; these items are not included in our one year projections, but would have to be considered as candidates for a stockage list and considered in a future calculation of actual accommodation.

A technical note will be published concerning the accuracy of the projection statistics and the impact of a 2 year base period on the projected values.

## APPENDIX C

### MANUAL SCREENING OF (TEST) KOREAN STOCKAGE LIST

In Table C-1 is a list of all items (419) which in the Korean test were definitely off the list by the economic criteria, but definitely on by demand criteria.

The items were coded as A, B, or C. The C category was for items for which delays in processing requisitions could be tolerated. If an item falls into the C category and is not economical to stock, it is a good candidate for removal from a stockage list.

The B category was for seasonal items, or for items for which most demands could be programmed. These items' demand fluctuations are known functions of seasonal or operational changes and the demand can be predicted accurately. If an item falls into the B category, and is not economical to stock, it is a candidate for special management and direct delivery rather than stockage.

The A category was comprised of essential items only.

Classification of the 419 items was done by four analysts in a few hours time. Since none of the analysts had great familiarity with the items, the classification was for demonstration purposes only - of what might be expected if more expert people did the classifications.

The "D" category included items the analysts could not assign.

Summary statistics were computed and are given in Table C-0. These tables give a breakout of the A, B, C, D categories by MATCAT.

The investment value in terms of dollar value of reorder point and reorder quantity is also given. From this is obtained an estimate of savings when the appropriate categories are deleted from the stockage list.

**A CARDS**

<b>MATCAT</b>	<b>NUMBER-PSNS</b>	<b>RECURRING-DEMANDS</b>	<b>\$-REORDER-POINT</b>	<b>\$-REORDER QTY</b>
B	16	402	379832.69	35678.34
F	1	26	11843.37	1410.39
G	20	168	138258.88	27365.50
H	12	68	425903.00	145383.75
J	24	474	350602.69	29900.90
K	41	2312	1022862.63	67349.50
M	8	136	262422.19	21259.31
Q	1	16	5472.00	976.39
R	13	882	668705.13	33202.60
T	1	21	3306.96	745.43
<b>TOTALS</b>	<b>137</b>	<b>4505</b>	<b>3269207.00</b>	<b>363272.88</b>

**B CARDS**

(Over \$10,000 Ext. Price)

B	1	15	3640.00	767.19
F	30	1244	475357.00	44439.06
J	5	66	190159.06	10923.62
K	9	790	393092.44	20381.82
R	2	143	83769.06	4864.89
<b>TOTALS</b>	<b>47</b>	<b>2258</b>	<b>1146017.00</b>	<b>81376.56</b>

**B CARDS**

(Under \$10,000 Ext Price)

K	2	38	4541.68	1237.47
<b>TOTALS</b>	<b>2</b>	<b>38</b>	<b>4541.68</b>	<b>1237.47</b>

**TABLE C-O - SUMMARY STATISTICS FOR MANUALLY  
SCREENED ITEMS**

<u>C CARDS</u>				
(Over \$10,000)				
CAT	NUMBER-FSNS	RECURRING-DEMANDS	\$-REORDER POINT	\$-REORDER-QTY
S	11	364	447829.25	22910.22
	48	1722	677441.56	66103.50
★	37	2245	822925	64644
J	45	1717	1255444.00	75919.00
K	6	225	85390.56	8758.99
	1	35	4189.65	838.70
	5	52	116261.31	7259.41
	7	468	286283.88	16798.37
T	9	260	135055.19	11445.41
TOTALS	170	7241	3830817.	274677.

\* PSN #72101711099 was excluded because of suspicious data

<u>C CARDS</u>				
(Under \$10,000)				
E	12	174	18323.79	6008.25
J	5	35	7249.89	2464.14
K	1	18	965.74	403.49
TOTALS	18	227	26539.43	8875.87

<u>"D" CARDS</u>				
B	5	111	1586029.00	21566.54
E	6	104	17056.39	3989.23
F	8	285	78097.63	9815.49
G	2	21	14145.00	2190.98
J	10	186	72096.63	9780.02
K	8	843	118955.13	10251.82
M	1	11	3297.00	728.57
TOTALS	40	1561	1889675.00	58322.64

TABLE C-0 SUMMARY STATISTICS FOR MANUALLY  
SCREENED ITEMS

NAV	FSN	NAME	UI	RECOV/EXP	ESS	WT.	CUBE	REC.DEFNS	REC. QTY	UNIT PRICE	EXTENDED PRICE
B	6115 552674	CONTROL COVER EA	C		M	20.82	0.12	68	120	354.00	42480.
B	20151050174	ENGINE,DIESEL EA	C		E	0.0	0.0	10	15	2999.00	44985.
B	61301439328	COMPRESSOR,EO EA	C		E	0.0	0.0	15	17	1309.00	22253.
B	20156031330	ENGINE DIESEL EA	D		M	4145.50	126.00	16	27	6192.00	167186.
B	30107417086	PARTS KIT,UNI EA	C		E	2.30	0.03	21	10049	6.12	61503.
B	20057635916	ENGINE BLOCK EA	C		E	796.00	19.80	36	58	1136.00	65772.
B	29907856164	GOVERNOR DIES EA	C		E	31.51	0.53	10	11	1025.00	11275.
B	20157896521	TURBOCHARGER EA	C		M	0.0	0.0	32	48	510.00	24480.
B	20158221073	ENGINE DIESEL EA	C		E	18.50	0.08	10	6	2873.00	17228.
B	20058725971	ENGINE GASOLI EA	B		E	160.00	8.75	12	47	593.00	27871.
B	20058725972	ENGINE GASOLI EA	C		E	215.00	11.65	47	111	746.00	87074.
B	20159650297	ENGINE,DIESEL EA	C		M	2100.00	73.20	25	20	2660.00	53200.
B	61159669164	ACTUATOR EA	C		E	4.75	0.15	43	2230	272.00	606560.
B	24209630058	STARTER ENGIN EA	C		E	69.20	1.29	21	73	166.00	12118.
B	2990995011	TURBOCHARGER EA	C		E	85.18	1.89	19	37	553.00	27461.
B	23209999942	TRANSMISSION, EA	C		M	0.0	0.0	17	16	2094.00	33534.
F	83405774168	SWITCH RELF NO EA	D		E	3.80	0.40	26	5858	6.92	40596.
E	5855 121945	IGNITER ASSY EA	C		P	0.13	0.01	14	36	328.57	11829.
G	5821 431987	AMPLIFIER OSC EA	C		E	0.75	0.03	9	30	395.00	11450.
G	58055032776	TELEPHONE SET EA	C		E	5.25	0.23	6	990	11.52	11405.
G	6448521944	RADIOSONDE SE EA	B		E	62.00	8.65	13	2724	19.80	54014.
G	61305714092	CHARGER, BATT EA	C		E	32.59	1.42	7	8	1778.00	13824.
G	58405877062	ASSEMBLY EA	C		P	65.00	3.86	7	16	5264.00	84224.
G	61107088872	VOLTAGE REGUL EA	C		P	65.00	3.58	6	15	1241.20	18615.
G	61307859062	CHARGER, BATT EA	C		E	120.00	2.02	10	16	717.00	11472.
G	61407892118	BATTERY, STOR EA	B		E	42.00	0.65	8	48	231.00	11048.
G	61358375331	BATTERY, VET. EA	B		E	80.00	3.75	7	19	1172.00	22230.
G	58058447158	CIRCUIT CARD EA	D		P	2.87	0.13	7	22	495.00	10890.
G	58058546857	CIRCUIT CARD EA	C		P	1.72	0.13	7	31	552.00	17112.
G	58058548827	CIRCUIT CARD EA	C		P	1.72	0.13	8	35	596.00	20510.
G	58058546955	CIRCUIT CARD EA	C		P	1.10	0.08	8	41	474.00	19434.
G	58058573063	POWER SUPPLY EA	B		P	14.00	0.36	7	19	1335.55	26325.
G	58108720955	TUBE AND CAPS EA	C		P	2.30	0.11	12	19	1091.00	20729.
G	58208793149	POWER SUPPLY EA	C		P	0.0	0.0	12	12	2314.82	27778.
G	58409112379	POWER SUPPLY EA	C		P	23.00	1.13	7	14	747.00	10360.
G	59609379352	ELECTRON TUBE EA	C		E	0.13	0.01	6	19	2641.49	50188.
G	58209733585	GENERATION, PU EA	C		E	0.46	0.01	7	218	57.04	12435.
M	1615 725799	BLADE ROTARY EA	B		E	543.00	86.50	6	30	3239.00	97170.
M	31101350560	BEARING,RULE EA	C		N	0.0	0.0	5	64	491.00	30784.
M	16801796047	HOIST ASSY,IN EA	C		N	0.0	0.0	5	8	8227.00	65816.
M	16151830834	TRANSMISSION EA	B		N	0.0	0.0	10	19	11627.00	220790.
M	20106240648	ENGINE,AIRCRA EA	B		N	1300.00	1.04	4	6	17342.00	104040.
M	16157445851	TRANSMISSION, EA	B		N	312.00	22.00	4	20	8416.00	168320.
M	2915787928	FUEL CONTROL, EA	C		E	0.0	0.0	6	6	5797.00	34782.
M	16158331556	MUFFLE,EXHAUST EA	B		E	505.00	7.05	9	17	3699.00	61353.
M	26106734418	ENGINE,AIRCRA EA	B		N	995.00	96.00	4	10	4237.00	42370.
M	15609182442	TAIL ROOM ASS EA	C		E	0.13	22.00	5	6	8424.00	50574.
M	26409556875	ENGINE,AIRCRA EA	B		N	1195.00	75.00	5	6	71724.00	430344.
M	65905918894	MAGNETO,IGNIT EA	V		E	0.0	0.0	5	38	1237.00	47006.
J	2815 735962	HEAD,CYLINDER EA	D		E	0.0	0.0	7	19	249.00	4712.

TABLE C-1 "A" ITEMS

J	30302670633	UNIT PRICE	11	0.0	0.0	7	1362	3.73	507
J	48202674620	UNIT PRICE	EA	0.76	0.11	74	175	222.00	300
J	29103640926	UNIT PRICE	EA	2.18	0.04	7	114	31.20	300
J	47203505557	UNIT PRICE	EA	8.00	0.37	108	100791	4.37	460527
J	29106055847	UNIT PRICE	EA	9.80	0.20	7	61	56.00	300
J	38206417646	UNIT PRICE	EA	4.00	0.02	13	478	27.20	1372
J	25207312699	UNIT PRICE	EA	27.00	5.50	7	8	427.00	300
J	28057411707	UNIT PRICE	EA	60.83	3.00	11	151	116.14	1210
J	25107617306	UNIT PRICE	EA	133.00	0.93	42	312	118.00	300
J	45207645555	UNIT PRICE	EA	0.0	0.0	20	9765	25.75	221
J	29207626565	UNIT PRICE	EA	113.00	4.30	7	19	603.00	1200
J	48208048529	UNIT PRICE	EA	0.0	0.0	7	1130	10.00	1200
J	45208476629	UNIT PRICE	EA	3.00	0.26	11	3572	6.30	2200
J	41108891169	UNIT PRICE	EA	0.0	0.0	18	134	416.00	600
J	2815078955	UNIT PRICE	EA	40.00	1.10	12	64	164.00	1200
J	2909116207	UNIT PRICE	EA	400.00	2.00	7	11	574.00	600
J	25209307506	UNIT PRICE	EA	2.46	0.50	7	10	2714.00	2714
J	25209307114	UNIT PRICE	EA	383.00	20.00	7	11	411.00	5921
J	42104331610	UNIT PRICE	EA	0.0	0.0	11	2042	14.70	3817
J	28150665839	UNIT PRICE	EA	0.0	0.0	7	71	90.00	1200
J	28050993324	UNIT PRICE	EA	0.0	0.0	12	19	960.00	1200
J	25309993202	UNIT PRICE	EA	0.0	0.0	13	41	305.00	1200
J	2615 105169	UNIT PRICE	EA	0.0	0.0	52	130	1220.00	15920
J	28051679049	UNIT PRICE	EA	2834.00	84.90	118	183	571.00	17118
J	29301695759	UNIT PRICE	EA	0.0	0.0	32	160	981.84	15000
J	2920226559	UNIT PRICE	EA	0.0	0.0	70	220	137.00	30160
J	29202943360	UNIT PRICE	EA	81.00	1.86	150	354	94.83	33797
J	25202925134	UNIT PRICE	EA	47.50	0.92	20	184	92.93	17099
J	2920334677	UNIT PRICE	EA	116.00	0.83	20	71	84.12	600
J	25405049080	UNIT PRICE	EA	8.78	0.25	186	8176	59.18	43157
J	2920563299	UNIT PRICE	EA	112.00	1.44	21	30	198.00	5940
J	2520590073	UNIT PRICE	EA	143.00	3.50	45	103	625.00	66275
J	25906278314	UNIT PRICE	EA	625.00	14.00	18	22	1213.00	26180
J	29206319700	UNIT PRICE	EA	76.00	0.53	24	212	139.00	29465
J	2590678777	UNIT PRICE	EA	45.00	1.24	29	70	513.00	39104
J	2520682700	UNIT PRICE	EA	12.78	0.39	18	29	389.00	11261
J	611545020	UNIT PRICE	EA	2.56	0.09	21	79	42.60	3365
J	2520685641	UNIT PRICE	EA	312.00	7.69	20	30	307.00	9210
J	2530722320	UNIT PRICE	EA	566.00	18.00	27	43	2136.00	61840
J	2530722320	UNIT PRICE	EA	37.00	1.95	16	57	58.96	3361
J	2530722320	UNIT PRICE	EA	129.00	2.89	27	346	59.16	20469
J	2530722320	UNIT PRICE	EA	75.00	1.20	18	20	278.00	5560
J	2530722320	UNIT PRICE	EA	1850.00	84.00	28	48	1198.00	57604
J	2530722320	UNIT PRICE	EA	211.00	2.15	19	24	436.00	12644
J	2530722320	UNIT PRICE	EA	56.00	1.23	20	23	146.00	3312
J	2530722320	UNIT PRICE	EA	1277.00	0.27	20	60	209.00	12553
J	2530722320	UNIT PRICE	EA	56.00	63.80	35	67	1265.00	86795
J	2530722320	UNIT PRICE	EA	56.00	1.04	18	43	163.00	7009
J	2530722320	UNIT PRICE	EA	40.50	0.77	126	304	134.41	40811
J	2530722320	UNIT PRICE	EA	6.66	0.24	306	12498	8.65	10821

TABLE C1 "A" ITEMS

NAV	FSN	NAME	UI	REC'D/EXP	ESS	WT.	CURE	REC.DEMS	REC. QTY	UNIT PRICE	EXTENDED PRICE
K	29208844836	DRIVE ENGINE	EA	V	P	1.87	0.02	20	282	44.60	12972.
K	29209019682	PROPELLER SMA	EA	D	P	21	2.30	303	76	143.00	5148.
K	29209073334	GENERATOR	EA	D	E	67.50	0.92	303	876	146.00	120596.
K	29109086320	PUMP FUEL MET	EA	D	E	40.00	3.00	61	108	330.00	35640.
K	28159108218	ENG	EA	C	E	4002.00	28.00	19	25	4990.00	122250.
K	28159113445	ENG MAINT LO	EA	C	E	1800.00	15.00	183	360	3233.50	1164060.
K	29109115755	TANK FUEL ENG	EA	D	P	78.00	9.50	55	600	94.24	59544.
K	29309117635	WHEEL SOLID R	EA	D	P	2192.25	2.11	25	180	67.06	12071.
K	29059124109	ENGINE WITH C	EA	D	P	1385.00	50.30	20	28	1407.00	39200.
K	28059273281	CRAWLSHAFT AS	EA	D	P	90.28	2.28	21	273	84.25	23000.
K	29209333981	ENGINE GASOL	EA	D	P	0.0	0.0	19	165	446.13	73611.
K	28059734975	ENG ORD 57035	EA	D	E	0.0	0.0	26	45	573.79	33280.
K	28159878669	ENG DSL M578	EA	C	E	0.0	0.0	28	84	2502.00	222678.
K	10054167463	WALY ASSEMBLY	EA	C	E	4.63	0.11	28	230	2545.00	116325.
M	10258537572	BOX ASSEMBLY	EA	C	E	22.50	0.90	22	22	59.33	13646.
M	12208613842	DISK, MEMORY	EA	C	E	32.00	0.32	16	19	1119.00	24618.
M	12208413845	MATRIX BW, 2	EA	C	E	16.75	2.11	9	34	7995.00	143910.
M	12208613845	READ AMPLIFIER	EA	C	E	1.00	0.15	16	304	1210.00	41140.
M	10259084113	AMPLIFIER INT	EA	C	E	14.25	0.50	18	28	116.00	353104.
M	61259169088	NOISE-GENERAT	EA	C	E	655.00	12.00	15	23	587.00	16436.
M	10059878948	SLIDE AUTOMAT	EA	C	P	0.76	0.02	12	3824	1029.00	23667.
M	94601078133	ELECT TUBE SJ	EA	D	E	30.00	2.00	16	32	76.01	290662.
R	91502312391	LUB OIL G2 MI	QT	D	E	2.33	0.06	37	138927	608.00	19456.
R	91502316489	LUB OIL GEN P	QT	D	E	463.00	12.00	69	186660	0.52	72242.
R	91502659429	LUB OIL ENG M	DR	K	E	52.60	1.72	71	9540	7.31	57865.
R	91502659435	LUB OIL ENG M	PL	K	E	479.00	12.00	22	7394	27.30	261534.
R	91502659443	LUB OIL ENG M	OR	K	E	414.25	12.00	40	2976	3.31	24474.
R	91302732375	AVGAS CR 115/	DR	H	E	443.45	12.00	25	902	28.50	84816.
R	91302732380	TURBINE FUEL	DR	H	E	7.03	0.13	53	3024	17.37	15668.
R	91402865284	FUEL OIL DIES	GL	H	E	456.87	12.00	104	4865	14.13	55446.
R	91402865288	FUEL OIL DIES	DR	H	E	484.00	12.00	65	3604945	15.12	134039.
R	91505775845	LUB OIL GEAR	DR	K	E	484.00	12.00	72	37860	0.13	468030.
R	91506801106	LUB OIL ENG MI	DR	K	E	484.00	12.00	188	13731	15.12	572443.
R	91507822627	LUB OIL ATE MI	QT	D	E	2.25	0.06	56	2003	32.70	449004.
T	53062634738	BOLTMACHINE	EA	D	P	3.20	0.02	80	32405	29.30	58688.
								21	10500	1.17	37914.
										1.08	11340.

## "A" ITEMS

K 26106402071	TIRE, PNEUMAT, EA	D	P	141.00	13.60	18	84	84.05	7060.	
K 25409596212	MODIFICATION	EA	D	P	0.0	0.0	20	167	51.52	8604.

## "B" - UNDER \$10,000 EXT PRICE - ITEMS

TABLE: C-1

X

MAT	FSM	NAME	UI	RECOV/EXP	ESS	WT.	CUBE	REC.OEHS	REC. QTY	UNIT PRICE	EXTENDED PRICE
B	43206497571	HEATER SPACE	EA			40.00	1.08	15	33	364.00	12012.
F	84151600769	MITTEN INSERT	PR	D	E	0.28	0.02	26	10067	1.10	11074.
F	84052616502	OVERCOAT MANS	EA	Y	N	6.25	0.29	20	584	23.00	17632.
F	84152667750	MOND EXTREME	EA	D	N	0.76	0.16	25	4616	5.25	24234.
F	84152695700	GLOVE SHELLSC	PR	D	E	0.32	0.01	83	16633	2.91	48402.
F	84157822933	COAT COLD MEA	EA	D	E	3.20	0.22	37	3497	14.40	50357.
F	84157822935	COAT COLD MEA	EA	D	E	3.33	0.24	75	20825	14.40	299880.
F	84157822936	COAT COLD MEA	EA	D	E	3.40	0.24	68	9921	14.40	142862.
F	84157822937	COAT COLD MEA	EA	D	E	3.47	0.22	41	3624	14.40	51898.
F	84157822938	COAT COLD MEA	EA	D	E	3.40	0.22	53	5177	14.40	74549.
F	84157822939	COAT COLD MEA	EA	D	E	3.47	0.22	73	8812	14.40	126893.
F	84157822941	COAT COLD MEA	EA	D	E	3.53	0.22	26	816	14.40	11750.
F	84157822943	COAT COLD MEA	EA	D	E	3.47	0.23	23	835	14.40	12024.
F	84307823095	BOOT COMBAT4	PR	D	E	2.75	0.35	135	13357	9.50	126892.
F	84308237031	BOOT INSULATE	PR	D	E	5.60	0.42	22	285	39.10	11143.
F	84308237032	BOOT INSULATE	PR	D	E	5.60	0.42	22	522	39.10	23410.
F	84308237036	BOOT INSULATE	PR	D	E	5.60	0.42	31	611	39.10	23890.
F	84308237037	BOOT INSULATE	PR	D	E	5.60	0.42	26	651	39.10	25454.
F	84308237041	BOOT INSULATE	PR	D	E	5.60	0.42	25	704	39.10	27526.
F	84308237042	BOOT INSULATE	PR	D	E	5.60	0.42	24	758	39.10	29638.
F	84308237046	BOOT INSULATE	PR	D	E	5.60	0.42	26	1152	39.10	45043.
F	84308237047	BOOT INSULATE	PR	D	E	5.60	0.42	32	910	39.10	35581.
F	84308237051	BOOT INSULATE	PR	D	E	6.00	0.50	29	1175	39.10	45942.
F	84308237056	BOOT INSULATE	PR	D	E	6.00	0.50	22	626	39.10	24477.
F	84308237061	BOOT INSULATE	PR	D	E	6.00	0.50	21	893	39.10	34916.
F	84458237622	FIELD PACK CA	EA	D	E	1.02	0.09	21	5245	2.36	12378.
F	84059247935	PARKA WET MEA	EA	D	E	2.08	0.39	57	6124	7.77	47583.
F	84059247936	PARKA WET MEA	EA	D	E	2.08	0.39	87	8746	7.77	67956.
F	840593353	PONCHO COATE	EA	D	N	0.0	0.0	31	12063	8.48	102294.
F	84059857327	OVERALLS WET	PR	D	E	1.58	0.20	38	5614	8.83	49572.
F	84059857328	OVERALLS WET	PR	D	E	1.58	0.20	37	3614	8.83	31912.
J	68302920129	X OXYGEN TECH	CY	K	E	154.00	3.36	16	1314	44.74	58788.
J	68302920132	HYDROGEN TECH	CY	K	E	137.75	0.28	8	223	55.00	12265.
J	45209123871	HEATER SPACE	EA	V	N	1.79	0.01	11	1512	46.30	70066.
J	45209836375	VALVE HEATER	EA	D	N	0.0	0.0	11	3562	120.00	427440.
K	26102607354	INNER TUBE PN	EA	D	P	9.50	0.63	39	4690	17.80	83482.
K	26102628653	TIRE PNEUMATI	EA	D	E	119.20	14.40	374	100121	5.58	558675.
K	26102948800	TIRE PNEUMATI	EA	D	P	93.00	6.15	29	6133	67.87	416247.
K	25403368053	HEATER VEMICU	EA	D	P	46.56	2.42	26	189	62.34	11782.
K	26105404725	TIRE PNEUMATI	EA	D	E	150.40	14.30	88	83	197.00	16351.
K	26105546222	TIRE PNEU 29	EA	D	E	104.00	0.90	24	392	129.00	50568.
K	26105546250	TIRE PNEU 140	EA	D	E	280.00	22.00	83	84	997.00	83748.
K	25307817793	SHOE ASSEMBLY	EA	D	P	0.0	0.0	50	274	181.61	49761.
K	25409333980	PARTS KIT MEA	EA	D	P	47.50	3.85	77	8566	14.82	126948.
R	68502246730	ANTIFREEZE PE	PL	D	E	42.00	2.01	39	430	83.09	35729.
R	68502431990	ANTIFREEZE PE	DR	D	E	550.00	12.00	104	7817	4.92	38558.
RECORDS WRITTEN											
15537											
JOB ENDED AFTER											

"B" - OVER \$10,000 EXT. PRICE - ITEMS

TABLE C-1

X

QTY	FSH	NAME	UT	RECDV/EXP	ESS	WT.	CUBE	REC.DENS	REC. QTY	UNIT PRICE	EXTENDED PRICE
0	55102206202	LUMBER, SOUTHW	EA	L	N	0.0	0.0	0.0	331546	0.99	328231.
0	45202308099	WEATER, DUCT T	EA	Y	E	0.0	0.0	0.0	22	1021.00	22462.
0	56102423792	CEMENT, PORTLA	BC	L	E	97.00	-1.67	0.0	83239	0.99	82407.
0	10002427795	CAP, CAROLUPLAG	EA	C	E	0.18	0.13	0.0	2064	6.53	13476.
0	80102406648	ENAMEL	PL	G	N	0.0	0.0	0.0	5059	10.30	52108.
0	50404182500	CLOTH, ASBESTO	RD	G	N	0.0	0.0	0.0	78	129.00	10062.
0	56607204527	FENCING, WIRE	RD	B	N	0.0	0.0	0.0	577	28.40	16387.
0	56408499850	BUILDING BOARD SH	SH	G	E	40.00	0.67	0.0	4250	3.55	15087.
0	81059262034	BAG SAND, POLY MD	MD	D	N	0.0	0.0	0.0	8561	16.20	138688.
0	81059262035	BAG SAND, POLY MD	MD	D	N	14.50	1.30	0.0	46252	16.20	749282.
0	81059652509	BAG, SAND	MD	D	N	0.0	0.0	0.0	6702	16.20	108572.
0	7330 785706	BOARD, FOOD CM EA	EA	G	E	17.00	0.20	0.0	5348	7.55	40377.
0	73501623006	CUP, PAPER	CT	C	E	40.00	1.00	0.0	5525	8.30	45857.
0	73501708341	MUSTARD POT C EA	EA	V	N	0.0	0.0	0.0	100344	1.20	120413.
0	41101941572	REFRIGERATOR EA	EA	D	E	1160.00	169.00	0.0	58	938.00	63784.
0	72202244400	TILE ASPHULTY	EA	L	N	0.0	0.0	0.0	197868	0.12	23744.
0	73502247701	CUP PAPER RD CT	CT	G	E	35.00	3.50	0.0	1171	13.10	15340.
0	79302247901	SOAP, LAUNDRY DR	DR	G	E	0.0	0.0	0.0	1398	11.00	15378.
0	93602398281	GLASS LAMINAT EA	EA	D	N	15.38	0.23	0.0	1841	7.30	13439.
0	74202406358	BRUSH, DUSTING EA	EA	G	N	0.50	0.13	0.0	201843	1.30	262396.
0	73502425110	PAN MESS KITC EA	EA	D	E	1.15	0.07	0.0	8033	1.36	10925.
0	73102428411	URN COFFEE TW EA	EA	D	E	102.00	10.00	0.0	22	965.00	21230.
0	73302494842	PAPER TAB MCH CT	CT	K	N	0.0	0.0	0.0	1553	10.50	16307.
0	73302494843	PAPER, TABULAT CT	CT	K	E	0.0	0.0	0.0	990	13.10	12969.
0	73302494844	PAPER, TABULAT CT	CT	K	E	0.0	0.0	0.0	9033	11.60	104783.
0	73302494845	PAPER TAB 5 P CT	CT	K	N	0.0	0.0	0.0	5403	1.40	72400.
0	73302494846	PAPER TAB 6 P CT	CT	K	N	0.0	0.0	0.0	4731	12.50	59138.
0	73302494847	PAPER, TABULAT CT	CT	K	E	0.0	0.0	0.0	2192	10.00	21920.
0	78202551159	PLAYING COS-P DK	DK	L	N	0.0	0.0	0.0	4649	32.89	152906.
0	78202551161	PLAYING CARDS DK	DK	L	N	0.0	0.0	0.0	6647	32.89	218620.
0	71052670246	BEDE FOLDING EA	EA	V	N	50.00	3.20	0.0	1060	13.30	14098.
0	73102686433	OVEN BAKING A EA	EA	M	E	1669.00	130.00	0.0	15	1340.00	20100.
0	71052699217	WARDROBE, MET EA	EA	G	E	0.0	0.0	0.0	634	51.00	32334.
0	71052699275	TABLE FOLDING EA	EA	D	E	48.00	3.43	0.0	981	11.90	11674.
0	73102711734	RANGE OIL BUR EA	EA	D	E	24.50	0.90	0.0	1806	16.00	28896.
0	73302812796	PAPER OVERLAY RM	RM	L	N	1360.00	59.80	0.0	21	669.00	14049.
0	81352814071	STRAPPING-STL CL	CL	G	E	114.88	1.07	0.0	406	29.10	11815.
0	93402818070	GLASS LAMINAT EA	EA	D	N	42.00	0.76	0.0	727	14.40	10469.
0	93902824161	DIATONACEOUS BG	BG	D	E	50.00	2.50	0.0	2669	4.00	10676.
0	81352830667	STRAPPING CL	CL	G	N	820.16	6.97	0.0	2302	16.30	37523.
0	81352830671	STRAPPING CL	CL	L	N	0.0	0.0	0.0	2967	13.50	40055.
0	74302869023	TYPEWRITING N EA	EA	A	E	34.00	1.30	0.0	158	218.00	34444.
0	81352901086	SEAL STRAP-OP BX	BX	G	E	43.00	1.00	0.0	1139	11.60	13212.
0	81352922345	TAG, BLANK	MX	G	E	0.0	0.0	0.0	2787	10.40	28985.
0	74602929224	FILE VISIBLE EA	EA	L	E	0.0	0.0	0.0	87	160.00	13920.
0	52102930535	WRENCH SET CO SE	SE	G	E	20.00	1.50	0.0	11851	11.50	136287.
0	91203244334	WRENCH SET SO SE	SE	G	N	0.0	0.0	0.0	798	54.20	43252.
0	81055592561	BAG PAPER-KRA BE	BE	G	N	0.0	0.0	0.0	8071	4.90	39543.
0	93405996666	GLASS LAMINAT EA	EA	D	N	73.33	3.33	0.0	1665	19.70	32800.

TABLE C-1 "C" - OVER \$10,600 EXT PRICE - ITEMS

MAT	FSN	NAME	UI	RECOV/EXP	ESS	WT.	CUBE	REC.DENS	REC. QTY	UNIT PRICE	EXTENDED PRICE
E	71106330720	CHAIR STRAIGHT CT	G		E	0.0	0.0	37	326	73.00	23798.
E	79304343935	SOAP LMDRY-CH DR	G		E	0.0	0.0	28	698	21.20	14796.
E	75306633716	PAPER CY-THER VC	L		M	0.0	0.0	31	551	21.25	11709.
E	71256802764	LOCKER CLOTHI EA	G		E	87.54	2.73	66	5193	19.30	100225.
E	73507329500	CUP DRINKING DZ	G		E	1.08	0.04	17	3321	5.90	19594.
E	81152524490	BOX FIBROD-HA EA	G		E	26.30	2.66	16	5229	5.80	30328.
E	81157534691	BOX FIBROD-HA EA	G		E	26.00	2.70	23	20632	7.40	152677.
E	79208239772	TOMEL PAPER-2 CS	G		M	0.0	0.0	80	4847	16.10	78037.
E	41108376441	JCE MAKING MA EA	M		M	468.67	40.00	33	39	470.00	18330.
F	8405826610	TROUSERS MENS PR	D		E	1.35	0.17	124	50176	2.32	116408.
F	84551130224	INSGN SHLD AS EA	D		M	0.0	0.0	24	79788	0.13	10372.
F	84301441646	OVERSHOES RUD PR	D		E	4.10	0.27	30	3338	4.62	15422.
F	84051638683	TROUSERS MENS PR	D		M	1.14	0.06	63	14804	3.67	54331.
F	84051638684	TROUSERS MENS PR	D		M	1.14	0.06	63	10636	3.67	39034.
F	72101711099	SHEET BEDG CO EA	D		E	0.67	0.03	153	30146768	1.21	36477552.
F	84051883791	SHIRT MANSC W EA	D		E	1.08	0.13	50	11312	6.66	75338.
F	84051883798	SHIRT MANSC W EA	D		E	1.08	0.13	21	1556	6.66	10363.
F	84152317200	TROUSERS MENS PR	D		E	1.90	0.10	55	5725	8.50	48663.
F	84152317202	TROUSERS MENS PR	D		E	1.90	0.10	51	5248	8.50	44608.
F	84152317203	TROUSERS MENS PR	D		E	1.90	0.10	97	16826	8.50	143021.
F	84152317204	TROUSERS MENS PR	D		E	1.90	0.10	57	9149	8.50	77767.
F	84152317205	TROUSERS MENS PR	D		E	1.90	0.10	60	11980	8.50	101830.
F	84152317206	TROUSERS MENS PR	D		E	1.90	0.10	76	15830	8.50	134555.
F	84152317207	TROUSERS MENS PR	D		E	1.90	0.10	55	17922	8.50	152337.
F	84152317212	TROUSERS MENS PR	D		E	1.90	0.10	22	2043	8.50	17366.
F	84152016833	COVER HELMET EA	D		E	0.24	0.01	29	17926	0.79	14162.
F	84652616909	BAG WATERPROF EA	D		E	1.22	0.05	47	27015	1.81	48997.
F	84652654928	BAG DUFFELG C EA	D		E	2.42	0.10	62	9786	3.68	36012.
F	85402767569	NAPKIN TABLE CT	G		E	0.0	0.0	87	92435	10.10	92435.
F	72102827950	SHIRT MANSC BEDG EA	D		E	4.00	0.77	145	56390	7.12	401497.
F	84052929382	SHIRT MANSC C EA	D		M	1.06	0.07	74	24886	2.43	60473.
F	8465303692	BAG BARRACKS EA	D		E	1.00	0.10	58	25614	1.34	34323.
F	72105303730	MATTRESS BEDG EA	D		M	20.00	5.61	26	1349	12.40	16728.
F	85405303749	PAPER TOILET CT	G		E	0.0	0.0	112	27363	12.40	339301.
F	83405437787	TENTG GENERAL EA	D		E	300.00	13.10	41	295	456.00	134520.
F	8456470952	CASE SMALL AR EA	D		E	0.40	0.04	26	14255	1.55	22095.
F	72106826507	MATTRESS BEDG EA	L		M	28.00	10.36	49	2284	26.18	59795.
F	83407336570	TENTG GENERAL EA	B		E	123.00	8.40	44	150	378.00	56700.
F	84407622171	SOCK MENSE WO PR	D		E	0.18	0.00	83	86134	0.64	55126.
F	84407622172	SOCK MENSE WO PR	D		E	0.18	0.00	87	50714	0.64	32457.
F	84057823016	SHIRT MANSC C EA	D		E	1.32	0.05	112	46926	2.41	113092.
F	72108838492	COVER MATTRES EA	D		E	0.0	0.0	27	6778	2.67	18097.
F	84159045120	DRAWERS MENSE PR	D		E	0.70	0.10	83	50765	3.15	159910.
F	84159045121	DRAWERS MENSE PR	D		E	0.72	0.10	70	10377	3.15	32688.
F	84159045133	UNDERSHIRT MA EA	D		E	0.72	0.19	75	21742	3.03	65878.
F	84059651605	COAT MANSC PO EA	D		M	2.04	0.21	27	401	26.40	10586.
F	84059651615	COAT MANSC PO EA	D		M	2.04	0.21	33	637	26.40	16817.
J	4010 372939	WIRE ROPE STE RL	D		M	0.0	0.0	222	4086	55.00	224730.
J	4030 720713	WIRE ROPE ASS EA	D		E	126.00	2.30	66	625	55.00	34375.
J	6240 889041	LAMP, MERCURY EA	L		M	0.0	0.0	8	1090	13.00	14170.

TABLE C-1 "C" - OVER \$10,000 EXT PRICE - ITEMS

MAT FSN NAME UT RECOV/EXP ESS WT. CUBE REC.DEMS REC. QTY UNIT PRICE EXTENDED PRICE

J	25401632296	SUPPLY COUPL	EA	K	E	0.0	0.0	118	111.00	13098
J	93301297749	PLYWOOD	SH	L	P	0.0	0.0	14401	2.87	41331
J	93301297833	PLYWOOD	EA	L	P	0.0	0.0	5477	6.24	34176
J	47101621011	PIPE STEEL	FT	D	E	0.0	0.0	4640	2.51	11648
J	47101621023	PIPE STEEL	FT	D	E	0.0	0.0	45631	0.66	30116
J	91051989121	WIRE STEEL	CA CL	D	E	100.00	1.25	2854	14.60	41668
J	47102026755	PIPE STEEL	FT	D	E	19.00	0.24	13439	2.10	28222
J	91102206080	LUMBER, SOFTW	BF	L	M	0.0	0.0	119	0.10	162638
J	91102206082	LUMBER, SOFTW	BF	L	M	0.0	0.0	915007	0.11	1006514
J	91102206084	LUMBER, SOFTW	BF	L	M	0.0	0.0	704556	0.11	77501
J	91102206086	LUMBER, SOFTW	BF	L	M	0.0	0.0	833557	0.11	75191
J	91102206191	LUMBER, SOFTW	BF	L	M	0.0	0.0	2143422	0.11	235776
J	91102206198	LUMBER, SOFTW	BF	L	M	0.0	0.0	597753	0.10	59775
J	91102206226	LUMBER, SOFTW	BF	L	M	0.0	0.0	392770	0.13	51060
J	91102206196	STEEL PLATE, C	PH	D	E	330.46	1.15	640	22.30	14272
J	91102206220	STEEL PLATE, C	PH	D	E	250.91	0.50	1345	17.80	27501
J	91102206226	STEEL PLATE, A	PH	D	M	918.00	1.84	83	125.00	10379
J	91102206226	STEEL PLATE, A	PH	D	M	13.30	0.10	9900	1.17	11583
J	91102206226	STEEL PLATE, A	PH	D	M	53.40	0.13	2043	11.60	23644
J	47102731037	PIPE, CULVERT	EA	D	E	73.65	0.88	1808	18.30	33086
J	47102731042	PIPE, CULVERT	EA	D	E	34.00	3.90	4666	6.00	27996
J	45202731243	PIPE, CULVERT	EA	D	E	0.01	0.0	23450	0.70	16415
J	91102736783	LUMBER, SOFTW	BF	L	P	0.0	0.0	253250	0.15	37987
J	40102736631	WIRE ROPE, STE	RL	D	E	1000.00	15.00	55	323.00	17765
J	91102752574	LUMBER, SOFTW	BF	L	P	0.0	0.0	129838	0.11	14282
J	45102779559	SHOWER BATH F	EA	D	P	0.0	0.0	311	45.40	14119
J	81052854744	BAG, SAND	MO	D	E	60.00	3.70	3157	16.20	51143
J	62302996051	LIGHT, TABLE	EA	D	E	4.00	0.92	1533	12.10	18549
J	30303304498	BELT, V	EA	D	E	0.0	0.0	58047	4.74	275143
J	34603719494	K CONCERTINA	CL	D	E	58.57	0.02	3139	9.27	29099
J	91105519658	LUMBER, SOFTW	BF	L	P	0.0	0.0	220500	0.20	44100
J	91105519659	LUMBER, SOFTW	BF	L	P	0.0	0.0	690931	0.20	138186
J	91105519660	LUMBER, SOFTW	BF	L	P	0.0	0.0	539254	0.22	118636
J	91105519663	LUMBER, SOFTW	BF	L	P	0.0	0.0	72680	0.20	14536
J	91105519717	LUMBER, SOFTW	BF	L	P	0.0	0.0	278141	0.20	55628
J	91105519767	LUMBER, SOFTW	BF	L	P	0.0	0.0	578003	0.15	86700
J	95055541286	WIRE STEEL, CA	CL	D	E	12.00	0.86	8151	1.74	14183
J	95055596448	WIRE STEEL, CA	CL	D	M	112.42	3.30	1343	16.10	21622
J	40106187697	WIRE ROPE, STE	RL	D	E	478.00	5.40	693	227.00	157311
J	25407061090	SEAT THOOP	EA	D	P	52.00	1.00	100076	17.08	1709296
J	62407583367	LAMP, MERCURY	EA	D	E	0.67	0.21	2103	6.16	12954
J	61159411655	COVER, GENERAT	EA	D	E	7.02	0.66	111	660.00	73260
K	25403017267	KIT, HOT WATER	EA	D	P	72.00	3.70	369	98.40	36310
K	25403017269	KIT, HOT WATER	EA	D	P	88.00	5.40	99	128.00	12672
K	25906416405	WINCH, DRUM V	EA	D	E	468.00	17.50	84	411.00	34524
K	25907538687	WINCH, DRUM VE	EA	D	P	250.00	7.90	216	515.00	111240
K	25407801972	KIT, HARD TOP	EA	D	P	498.00	88.30	81	879.00	71199
K	25108585597	WINDSHIELD AS	EA	D	P	81.70	10.45	405	64.80	26244
M	10058092140	COVER, PROT RT	EA	C	N	13.43	0.50	908	15.81	14355
G	61451604781	WIRE	NS FT	D	E	0.03	0.0	711112	0.02	14222

TABLE C-1 "C" - OVER \$10,000 EXT. PRICE - ITEMS

X

MAT	FSN	NAME	UI	RECOV/EXP	ESS	WT.	CUBE	REC.DENS	REC.QTY	UNIT PRICE	EXTENDED PRICE
Q	61451912512	CABLE	FT	D	E	0.17	0.0	13	35910	0.42	15082.
Q	61451990230	CABLE	FT	D	E	0.39	0.01	15	46370	0.23	10665.
Q	59257878606	BREAKER	EA	D	F	20.00	1.04	7	32	320.00	10240.
Q	67509797677	PAPER,PHOTOGR	BX	D	P	1.75	0.06	9	12499	27.90	348722.
R	68102010904	ALCOHOL DENAT DR	DR	D	E	414.00	11.00	31	1169	37.80	44188.
R	68502097947	CLEANING COMP DR	DR	D	N	440.00	12.00	86	3263	33.00	107679.
R	72402223088	CAN GASOLINE	EA	D	E	9.50	0.87	82	12953	3.82	49480.
R	68102331715	SODIUM CARBON	RC	D	E	102.00	2.00	42	10809	3.21	34697.
R	6810250472	CALCIUM NYPOC	DR	D	E	114.00	3.40	54	7813	21.50	167980.
R	68502649037	DRY CLEANING	DR	K	E	431.00	12.00	151	8203	18.70	153396.
R	68402812062	INSECT REPELL	GL	D	N	11.36	0.17	22	69516	6.10	424048.
T	53401878193	TURNBUCKLE	EA	D	P	16.00	0.22	6	2185	9.48	20714.
T	53401880341	TURNBUCKLE	EA	D	P	12.00	0.30	8	3164	6.31	19965.
T	53502210872	CLOTH ABRASIV	PG	G	E	2.70	0.01	94	107316	2.90	311216.
T	53352629445	WIRE FABRIC	RO	D	P	0.0	0.0	12	662	26.40	17477.
T	53352811187	WIRE FABRIC	RO	D	P	144.00	0.90	8	67	209.00	14003.
T	53406821506	PADLOCK SET	SE	D	P	52.50	0.70	12	70	185.00	12950.
T	53407998184	PADLOCK	EA	D	P	0.0	0.0	33	561	19.40	10883.
T	53407998264	PADLOCK	EA	D	P	0.0	0.0	79	1905	21.70	41338.
T	53508893435	CLOTH ABRASIV	EA	D	P	0.0	0.0	8	4645	3.10	14399.
RECORDS WRITTEN											
JOB ENDED AFTER 17919											

TABLE C-1 "C" - OVER \$10,000 EXT PRICE - ITEMS

45

**TABLE C-1**

100 ENDED AFTER 10965 : RECORDS WRITTEN

DATE	F.S.N.	NAME	UT	REC'D/EXP	ESS	WT.	CUBE	REC'DEMS	REC. QTY	UNIT PRICE	EXTENDED PRICE
B	5602201669	LG	K	E		1.50	0.0	12	7777	2.30	17887.
B	6030600027	MELIUM, TECHN	K	N		0.0	0.0	14	262	55.38	14510.
B	752078942C	EA	C	E		96.00	0.64	19	26	440.00	11440.
R	5660921516	RO	B	N		0.0	0.0	55	12452	15.50	193006.
B	20409304771	ASPIRATOR	EA	N		0.0	0.0	11	100009	52.00	5200468.
E	01151839463	BD	C	N		0.0	0.0	15	842	4.85	4084.
E	70202033571	RE	V	N		60.00	3.00	18	939	13.90	13052.
E	51202930448	PUNCH, ALIGN	EA	E		0.25	0.01	23	3738	0.30	11231.
F	73505592377	DZ	C	N		0.0	0.0	19	4338	4.60	19955.
E	41405617991	FAN, VANE	EA	E		8.08	0.14	15	29	199.00	5771.
E	7510269204	EA	C	N		0.0	0.0	14	206	22.80	4697.
F	04151925409	MITTEN SHELLS	PR	N		0.42	0.03	29	11611	2.60	30189.
F	8462318714	CASE SLEEPING	EA	E		2.48	0.31	21	4437	7.99	35452.
F	04057822801	LINER EXTREME	EA	N		0.46	0.19	23	1273	10.75	13685.
F	0405782282	LINER EXTREME	EA	N		0.46	0.19	37	4233	10.75	45505.
F	0405782283	LINER EXTREME	EA	N		0.46	0.19	50	4902	10.75	51627.
F	0405782284	LINER EXTREME	EA	N		0.46	0.19	22	1080	10.75	11610.
F	04157822919	CAP INSULAT	EA	E		0.24	0.06	27	4196	3.37	14141.
F	72109356619	EA	D	N		2.35	0.21	76	25804	2.54	65542.
G	12603565138	PLATF. BASE	EA	J	P	43.00	3.33	7	127	201.00	25527.
G	59459121449	EA	D	E		0.0	0.0	14	42	559.00	23479.
J	2540540644	CHAIN ASSEMB	PR	E		22.00	0.36	10	12617	5.40	68132.
J	683060972	MONOCMLORODIF	CY	K	E	436.00	2.00	17	189	81.00	15309.
J	68302920133	X DICHLORODIF	CY	K	E	130.00	4.00	38	493	70.00	34510.
J	68302920134	DICHLORODIFLU	CY	V	P	0.0	0.0	7	76	55.00	4180.
J	68302920142	CARBON DIOXID	CY	K	E	120.00	4.00	62	2632	27.20	71590.
J	68302920732	X NITROGEN TF	CY	K	E	265.00	4.00	7	61	52.00	3172.
J	45203770742	DRAFT REGULAT	EA	D	N	2.13	0.48	7	2560	1.35	3456.
J	40205423308	ROPE NYLON	RL	D	E	0.0	0.0	7	8	664.00	5312.
J	39106064482	RELT ASSEMBLY	EA	D	E	0.0	0.0	18	28	435.00	12180.
J	45208740430	SEGMENT LOW F	EA	D	N	2.45	0.35	13	8103	3.74	30305.
K	2590533628	MODIFICATION	EA	V	P	57.00	1.22	18	892	4.16	3711.
K	26107265164	TIRE, PNEUMATI	EA	D	P	250.00	26.10	182	617	190.00	117230.
K	25107367608	WHEEL FIFTH	EA	D	E	502.00	1.33	20	47	223.00	10481.
K	75108097498	SURFBOARD	EA	Z	P	0.0	0.0	20	25	142.00	3550.
K	25209049105	EA	D	P		0.0	0.0	19	31	131.00	4061.
K	25409339024	CHAIN ASSEMB	PR	D	P	0.0	0.0	447	6224	30.13	187529.
K	25409339026	CHAIN ASSEMB	PR	D	P	0.0	0.0	71	1551	29.32	45475.
K	25409339030	CHAIN ASSEMB	PR	D	P	59.00	0.56	66	597	60.00	35820.
M	10259084125	HANDLE ASSEMB	EA	C	E	10.00	1.10	11	23	471.00	10833.

FOR FINED AFTER 12069 RECORDS WRITTEN

TABLE C-1 "D" ITEMS

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